67,200-544
2001-0094

METHOD OF MAKING TALL FLIP CHIP BUMPS

FIELD OF THE INVENTION

[0001] This invention relates to a process of forming a bump on a substrate.

BACKGROUND OF THE INVENTION

[0002] A flip chip microelectronic assembly includes a direct electrical connection of face down (that is, "flipped") electronic components onto substrates, such as ceramic substrates, circuit boards, or carriers using conductive bump bond pads of the chip. Flip chip technology is quickly replacing older wire bonding technology that uses face up chips with a wire connected to each pad on the chip.

[0003] The flip chip components used in flip chip microelectronic assemblies are predominantly semiconductor devices, however, components such as passive filters, detector arrays, and MEM devices are also being used in flip chip form. Flip chips are also known as "direct chip attach" because the chip is directly attached to the substrate, board, or carrier by the conductive bumps.

[0004] The use a flip chip packaging has dramatically grown as a result of the flip chips advantages in size, performance, flexibility, reliability, and cost over other packaging methods and from the widening availability of flip chip materials, equipment and services. In some cases, the elimination of old technology packages and bond wires may reduce the substrate or board

10021017.092502

area needed to secure the device by up to 25 percent, and may require far less height. Further, the weight of the flip chip can be less than 5 percent of the old technology package devices.

[0005] Flip chips are advantageous because of their high-speed electrical performance when compared to other assembly methods. Eliminating bond wires reduces the delay in inductance and capacitance of the connection, and substantially shortens the current path resulting in the high speed off-chip interconnection.

[0006] Flip chips also provide the greatest input/output connection flexibility. Wire bond connections are generally limited to the perimeter of the chip or die, driving the die sizes up as a number of connections have increased over the years. Flip chip connections can use the whole area of the die, accommodating many more connections on a smaller die. Further, flip chips can be stacked in 3-D geometries over other flip chips or other components.

[0007] Flip chips also provided the most rugged mechanical interconnection. Flip chips when underfilled with an adhesive such as an epoxy, can withstand the most rugged durability testing. In addition to providing the most rugged mechanical interconnection, flip chips can be the lowest cost interconnection for high-volume automated production.

[0008] The bumps of the flip chip assembly serve several functions. The bumps provided an electrical conductive path from the chip (or die) to the substrate on which the chip is mounted. A thermally conductive path is also provided by the bumps to carry heat from the chip to the substrate. The bumps also provided part of the mechanical mounting of the chip to the substrate. A spacer is provided by the bumps that prevents electrical contact between the chip and the

substrate connectors. Finally, the bumps act as a short lead to relieve mechanical strain between the chip and the substrate.

[0009] Flip chips are typically made by a process including placing solder bumps on a silicon wafer. The solder bump flip chip processing typically includes four sequential steps: 1) preparing the wafer for solder bumping; 2) forming or placing the solder bumps on the wafer; 3) attaching the solder bumped die to a board, substrate or carrier; and 4) completing the assembly with an adhesive underfill. A brief description of the prior art methods of performing the first step will provide a better background for understanding the present invention.

[0010] The first step in a typical solder bumping process involves preparing the semiconductor wafer bumping sites on bond pads of the individual integrated circuits defined in the semiconductor wafer. The preparation may include cleaning, removing insulating oxides, and preparing a pad metallurgy that will protect the integrated circuits while making good mechanical and electrical contact with the solder bump. Accordingly, protective metallurgy layers may be provided over the bond pad. Ball limiting metallurgy (BLM) or under bump metallurgy (UBM) generally consists of successive layers of metal. The "adhesion" layer must adhere well to both the bond pad metal and the surrounding passivation, provide a strong, low-stress mechanical and electrical connection. The "diffusion barrier" layer prevents the diffusion of solder into the underlying material. The "solder wettable" layer provides a wettable surface for the molten solder during the solder bumping process, for good bonding of the solder to the underlying metal.

10210157 . 092601